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ABSTRACT

Investigated were psychological differences between 24 mongoloid and 56 nonmongoloid retarded Ss (mean age 17 years) by means of analyses of covariance and a discriminant analysis. After the covariance adjustments, only the psychomotor factor differed significantly between mongoloid and nonmongoloid groups. The visual perception factor was the only mongoloid ability with a higher mean value than the same ability in nonmongoloids. (DB)

Risto Kääriäinen

DIFFERENCES IN ABILITY FACTOR PROFILES BETWEEN MONGOLOID AND NONMONGOLOID RETARDED SUBJECTS IN DISCRIMINANT ANALYSIS AND AFTER COVARIANCE ADJUSTMENTS

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Differences in ability factor profiles between mongoloid and nonmongoloid retarded subjects in discriminant analysis and after covariance adjustments.

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1 Introduction

Clinical psychologists are interested to study whether the etiological categories of the mentally retarded have distinct psychological characteristics. The Down's syndrome subjects or mongoloids are the best defined subgroup of the retardates and seems to have a fairly unique psychopathology. Therefore they have been most often investigated as a subgroup of retardates. Also the chromosomal nature of the Down's syndrome makes it an extremely interesting line of investigation.

If the different etiological categories of mental retardation have different psychological characteristics, not only differences in intellectual level, the etiological classification of retardates is not so restricted as without such distinct psychological characteristics. The present investigation concerned with intellectual side of the behavioral characteristics of the Down's syndrome.

Most of the earlier studies concerning the intellectual characteristics are listed in the review of Johnson and Olley (1971). O'Connor and Hermelin (1963) have conducted a research program on differences between mongoloid and nonmongoloid severely subnormal subjects and have a chapter in their book reviewing these investigations. However, most earlier studies have been univariate analyses. There have been few multivariate and factorial designs to analyse all relevant intellectual variables together.

The univariate studies in intellectual characteristics are classified in two categories according Johnson and Olley: mental abilities and sensory processes.

Of the former group can be mentioned the study of Murphy (1956), who compared three subgroups, brain-injured retarded, familial retarded and mongoloid. The mongoloid and the brain-injured groups have a lower MA and performance age than the familial group. Mongoloids resemble brain-injured retarded subjects in their quantity of ability (MA) and familial retarded subjects in the quality of their ability.

Lyle (1959,1960) showed that mongoloid subjects have significantly less verbal ability than nonmongoloids. No differences between subgroups were found in nonverbal MA.

Nakamura (1965) compared adult mongoloids and nonmongoloids matched for age, sex and IQ. Differences were found only on four of the 64 Stanford-Binet items. On three of these (upright formboard, building a block bridge and drawing a circle) the mongoloids were superior to the undifferentiated retarded subjects. On one item (repeating three digits) the undifferentiated retarded subjects were superior to the mongoloid subjects. It was concluded that mongoloid and undifferentiated adult retarded subjects displayed no differences in their intelligence test profiles.

The studies mentioned above suggest that test profile differences between mongoloid and nonmongoloid subjects are few and related to MA rather than medical classification.

Of the studies concerning sensory processes can be mentioned the study of Berkson (1960), who found mongoloids significantly slower than nonmongoloids in reaction time experiments.

O'Connor and Hermelin (1963) showed that mongoloids have a lower skin conductance level in GSR than nonmongoloids. There were no differences in visual discrimination and recognition of shapes. The mongoloids were worse than other imbeciles in copying and reproducing designs. In another study O'Connor and Hermelin (1961) found that the visual processes of mongoloids are superior when compared to an unselected nonmongoloid group.

O'Connor and Hermelin (1963) offer some suggestions for possible underlying mechanisms, which would account for the functional differences between these subgroups. The reaction time experiments and skin resistance are associated with muscle tone. The lowered muscular tension produced longer reaction time. Lack of muscle tone indicates a low state of arousal, which is held to be a function of the non-specific subcortical systems. The association between a low state of arousal, hypotonia and lack of responsiveness may be responsible for the differences between mongoloids and nonmongoloids.

Garrison (1958) and Clausen (1965) used Thurstone's PMA-factor tests in comparing mongoloid and nonmongoloid retarded subjects. The PMA data presented by Garrison show that the patterns of subgroups are similar and the group means identical. Clausen (1965) showed that the mongoloids are significantly lower in PMA Form 5-7 profile than all the other etiological categories of retardates. The mongoloids have a very similar pattern to the other retarded subgroups, but at a lower level. The subgroup of mongoloids was small in Clausens study. On a later study (Clausen, 1968) he showed that a comparison of mongoloids with nonmongoloids, matched for IQ, MA, CA, and male-female ratio, still showed some significant differences. The mongoloids seemed to be more impaired with regard to sensory functions and speed of perception than nonmongoloids. It has been speculated that the arousal mechanism with its relationship to the reticular formation has a general effect on the performance level of the various tests used. Clausen concludes that in addition to the general effect or impairment there must be special impairments in mongoloids.

Dingman (1968) showed that mongoloids uniformly have a negative mean factor scores on verbal ability and in the age groups of MA 2 and 4 years these deviations are of substantial size. The scores at MA 6 were in mongoloids slightly negative in all four factors. The age groups were small also in this study. Dingman did not find systematic differences either, expect the level difference, between mongoloid and nonmongoloid mentally retarded patients. He concluded that the differences seem to be due to developmental growth and not to genetic structure.

The present author has shown significant differences in four ability factors between mongoloids and nonmongoloids (Kääriäinen, 1970). The computerized generalized analysis of variance in four dimensional criterion space showed a highly significant difference ($p<.005$) between these groups as seen in Figure 1, in the dotted profiles. The differences are greatest in psychomotor and memory-quantitative factors.

All factor analytical studies mentioned here, with the exception of the Garrison study, have shown a level difference between mongoloids and nonmongoloids. Clear differences in patterns have not been shown.

According to Clausen (1968) and Kääriäinen (1970 b) these kinds of differences, at least to a limited degree, must be evident because the results of mongoloids in other tests (Clausen, 1968) and in the learning variable (Kääriäinen, 1970 b) can not be explained without postulating the existence of compensatory mechanisms in mongoloids.

To investigate further the possible differences in patterns between mongoloid and nonmongoloid retarded persons, the present investigation was made in the form of covariance analyses and sampling error adjustments to the subgroups in order to make them more comparable than in the earlier analyses.

2. Methods

2.1. Subjects

The sample consists of 80 moderately and severely mentally retarded subjects (Kääriäinen, 1970), 41 male and 39 female, with a mean chronological age of 17 years 4 months. 49 lived in institutions and 31 in open care. Down's syndrome cases were 24, nonmongoloids 56. As a criterion of mongolism were the antroposcopic observations of the author, instead of karyotype analysis.

2.2. Ability measurements

The four ability factor scores used in the author's earlier investigation (Kääriäinen, 1970) and the chronological age were used as variables in the statistical analyses. The factor scores were computed with the complete estimation method.

2.3. Statistical analyses

The computerized discriminant analysis was made with the MFISK program (Lange, 1969) for the five variables and the two subgroups to investigate nearer the discriminator and its correlations with the variables used.

The sampling error adjustments were made with the help of covariance analyses. It is a method for making allowance for uncontrolled variables and to set forth the sampling error adjustment, which is needed in testing the statistical significance of the difference between the corrected means of two or more subgroups. The method is applicable whenever it seems desirable to correct a difference on a dependent variable for known differences on other variables, which for some reason could not be controlled by matching or by random sampling procedures. The question is not what the results would be if the uncontrolled variables were held constant as in partial correlation, but rather what the results would be if the groups were made comparable with respect to the uncontrolled variables. The problem is to specify what effect the noncomparability of the groups with respect to uncontrolled variables has on the means of the dependent variable. The covariance adjustment method will not necessarily reduce the differences between the means on the dependent variable. With groups differing on uncontrolled variables, it is not only as proper, but also as necessary to use the covariance technique when the groups are nearly the same on the dependent variable as when they are different (McNemar, p 343-356).

In the present study the computerized analysis of covariance with multiple covariates, the BMD 04V program, was used to investigate the differences between the means of mongoloids and nonmongoloids. The method is designed to compute analysis-of-covariance information for one analysis-of-variance variable with multiple covariates and unequal group sizes. The BMD 04V program was made separately for all four ability factors and the age variable so that each ability factor and the age variable have separately been used as a dependent variable and all others as independent variables.

The statistical analyses were made with UNIVAC 1108 at the Computing Center of the University of Jyväskylä.

3. Results

The main results are given in Tables 1-5 and in Figure 1 for the covariance adjustment methods and in Table 6 for the discriminant analysis.

In Table 1 are the results of the covariance adjustment when factor I, visual perception, has been used as dependent variable and other four variables as independent variables.

The adjusted difference of the group means is not significant. Factor III, psychomotor, and factor II, memory-quantitative, have had a significant effect on the adjustment as seen in Table 1 in the table of coefficients.

Table 2 shows the results when factor II, memory-quantitative, has been used as dependent variable and all other variables as independent variables. The adjusted difference of the group means is not significant with the F-ratio, but the t-value of the difference between the means is slightly significant ($p<.10$). Factor IV, verbal, and factor I, visual perception, have had significant effects on the adjustment of factor II as seen in Table 2 in the table of coefficients.

Table 3 presents the results when factor III, psychomotor, has been used as dependent variable and all other variables as independent variables. The adjusted difference of the group means is significant (F: $p<.05$, t: $p<.02$). Factor I, visual perception, and factor IV, verbal, have had significant effects on the adjustment of factor III, psychomotor, as seen in Table 3 in the table of coefficients.

Table 4 contains the results when factor IV, verbal, has been used as dependent variable and all others as independent variables. The adjusted difference of the group means is not significant. Factor II, memory-quantitative, and factor III, psychomotor, have had significant effects on the adjustment of factor IV, verbal.

In Table 5 are the results when the chronological age variable has been used as dependent variable and all others as independent variables. The adjusted difference of the group means is not significant. None of the factors had significant effects on the adjustment of the age variable. It has not had significant effects on the adjustments of the four factor means, either.

Figure 1 presents the ability profiles before and after adjustments with covariates. The mean of factor I of mongoloids is .155 and highest of all other mongoloid adjusted ability factor means. Factor I has been the only mongoloid ability factor which after covariance adjustment is higher than the same nonmongoloid ability factor. The difference, however, is not significant.

The generalized Mahalanobis D-square in the discriminant analysis shows that the discriminant power of the variables used to separate the two groups is significant, but the classification according to the largest function in Table 6 shows that the classification is not appropriate when it is made only on the basis of the variables used.

The scaled coefficients of Fishers discriminant function in Table 6 show the relative contribution of each variable to the discriminator. Factor III, psychomotor, factor II, memory-quantitative, and factor I, visual perception have the greatest relative contributions (.68, .56, -.46) to the discriminator. The direction of the discrimination of factor I, visual perception, is not the same as of the other ability factors, as seen in Table 6 from coefficients of Fishers discriminant function.

The correlation between the Fishers discriminant function and the variables are seen in Table 6. They are high and positive in all ability factors, but low in chronological age variable (FI .57, FII .80, FIII .88, FIV .68, age .12).

4. Discussion

After the covariance adjustment analyses only the psychomotor factor III shows clear and significant difference between the mongoloid and nonmongoloid retarded subjects. Slight but nonsignificant differences were seen between subgroups in factor II, memory-quantitative, and in factor I, visual perception. The difference in factor IV, verbal, was not significant.

The psychomotor differences shown in the present study support the earlier results of Berkson (1960) and of O'Connor and Hermelin (1963) in reaction time, in motor speed, and in motor control experiments.

The present study shows also the interesting role of factor I in mongoloids. It has a direction of discrimination opposite to the other ability factors and after the covariance adjustment is the only mongoloid ability factor with a mean above the nonmongoloid mean. This result supports the finding of O'Connor and Hermelin (1961) and can explain the obtained differences in the discrimination learning results, where mongoloids were better than nonmongoloids (Kääriäinen, 1972). The obtained differences in patterns can also explain possible compensatory mechanisms postulated by Clausen (1968).

5. Summary

Computerized analyses of covariance with multiple covariates and a discriminant analysis were performed for the four ability factor scores: visual perception, memory-quantitative, psychomotor, and verbal and the chronological age variable to investigate the ability profile differences between mongoloid and nonmongoloid severely and moderately mentally retarded persons.

The sample consisted of 80 subjects, of which 24 mongoloids and 56 nonmongoloids.

After the covariance adjustments only the psychomotor factor showed significant difference between mongoloid and nonmongoloid subgroups. In the discriminant analysis the psychomotor, memory-quantitative, and visual perception factors had the greatest relative contribution to the discriminator. The direction of discrimination of the visual perception factor was opposite to the other ability factors. After the covariance adjustments the visual perception factor was also the only mongoloid ability with a higher mean value than the same nonmongoloid ability.

The results support the earlier findings obtained in univariate analyses in psychomotor and visual perception differences between these subgroups. The obtained differences in patterns support the special nature of the mongoloid ability structure.

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7. Tables and Figures

Table 1 Analysis of covariance table, table of coefficients, standard errors and computed t-values and table of adjusted means and standard errors and t-values for difference between means. BMD 04V. Factor I as dep.

Analysis of covariance table:

Source	ddf	YY	Sum-Squares (due)	Sum-Squares (about)	df	Mean-Square
Treatment (between)	1	5.0507				
Error (within)	78	67.8417	43.3985	24.4431	74	.3303
Treatment + error (total)	79	72.8923	47.7847	25.1077	75	
Difference for testing adjusted treatment means:				.6646	1	.6646

Null hypothesis. No difference among treatments after adjusting with covariates.

F (1, 74) = 2.01211 p N.S.

Table of coefficients, standard errors and computed t-values:

Treatment + error (total):

	coefficient	SE	t-value	p
Factor II	.4795	.1041	4.6044	p < .001
Factor III	.4401	.0904	4.8697	p < .001
Factor IV	.0161	.1062	.1512	N.S.
Age	-.0158	.0162	-.9740	N.S.

Table of adjusted means and SE:s and t-values for differences between means:

	Treatment mean	Adjusted mean	SE of Ad.mean	t-value
Mongoloid	-.3837	.1546	.1265	1.4020
Nonmongoloid	.1646	-.0662	.0794	N.S.

Table 2 Analysis of covariance table, table of coefficients, standard errors and computed t-values and table of adjusted means and standard errors and t-values for difference between means. BMD 04V. Factor II as dep.

Analysis of covariance table:

Source	df	YY	Sum-Squares (due)	Sum-Squares (about)	df	Mean-Square
Treatment (between)	1	9.7603				
Error (within)	78	62.0676	38.9883	23.0792	74	.3119
Treatment + error (total)	79	71.8279	47.7576	24.0702	75	
Difference for testing adjusted treatment means:				.9910	1	.9910

Null hypothesis. No difference among treatments after adjusting with covariates.

$F\ (1, 74) = 3.177 \quad p$ N.S.

Table of coefficients, standard errors and computed t-values:

Treatment + error (total)

	coefficient	SE	t-value	p
Factor I	.4596	.0998	4.6044	$p < .001$
Factor III	.0016	.1015	.0153	N.S.
Factor IV	.4538	.0899	5.0479	$p < .001$
Age	.0003	.0160	.0196	N.S.

Table of adjusted means and standard errors and t-values for differences between means:

	Treatment mean	Adjusted mean	SE of Ad. mean	t-value
Mongoloid	-.5335	-.1873	.1222	1.8557
Nonmongoloid	.2287	.0803	.0770	$p < .10$

Table 3 Analysis of covariance table, table of coefficients, standard errors and computed t-values and table of adjusted means and standard errors, and t-values for differences between means. BMD 04V. Factor III as dep.

Analysis of covariance table:

Source	df	YY	Sum-Squares (due)	Sum-Squares (about)	df	Mean-Square
Treatment (between)	1	11.2158				
Error (within)	78	58.2850	29.6736	28.6114	74	.3866
Treatment + error (total)	79	69.5007	38.3668	31.1340	75	
Difference for testing adjusted treatment means:				2.5226	1	2.5226

Null hypothesis. No difference among treatments after adjusting with covariates.

$F(1, 74) = 6.524 \quad p < .05$

Table of coefficients, standard errors and computed t-values:

Treatment + error (total)

	coefficient	SE	t-value	p
Factor I	.5458	.1121	4.8697	p < .001
Factor II	.0020	.1313	.0153	N.S.
Factor IV	.2302	.1153	1.9964	p < .05
Age	.0217	.0180	1.2044	N.S.

Table of adjusted means and standard errors and t-values for differences between means:

	Treatment mean	Adjusted mean	SE of Ad. mean	t-value
Mongoloid	-.5719	-.2925	.1340	2.6388
Nonmongoloid	.2452	.1255	.0851	p< .02

Table 4 Analysis of covariance table, table of coefficients, standard errors and computed t-values and table of adjusted means and standard errors, and t-values for difference between means. BMD 04V. Factor IV as dep.

Analysis of covariance table:

Source	df	YY	Sum-Squares (due)	Sum-Squares (about)	df	Mean-Square
Treatment (between)	1	6.7832				
Error (within)	78	63.0734	33.4294	29.6440	74	.4006
Treatment + error (total)	79	69.8566	40.2111	29.6455	75	
Difference for testing adjusted treatment means:				.0015	1	.0015

Null hypothesis. No difference among treatments after adjusting with covariates.

$F(1, 74) = .004$ p N.S.

Table of coefficients, standard errors and computed t-values:

Treatment + error (total)

	coefficient	SE	t-value	p
Factor I	.0190	.1255	.1512	N.S.
Factor II	.5589	.1107	5.0479	$p < .001$
Factor III	.2192	.1098	1.9964	$p < .05$
Age	.0232	.0175	1.3256	N.S.

Table of adjusted means and standard errors and t-values for differences between means:

	Treatment mean	Adjusted mean	SE of Ad. mean	t-value
Mongoloid	-.4448	-.0075	.1407	0.0646
Nonmongoloid	.1906	.0032	.0879	N.S.

Table 5 Analysis of covariance table, table of coefficients, standard errors and computed t-values and table of adjusted means and standard errors, and t-values for difference between means. BMD 04V. Age variable as dep.

Analysis of covariance table:

Source	df	YY	Sum-Squares (due)	Sum-Squares (about)	df	Mean-Square
Treatment (between)	1	4.1355				
Error (within)	78	1354.4419	102.2675	1252.1744	74	16.9213
Treatment + error (total)	79	1358.5774	102.5982	1255.9792	75	
Difference for testing adjusted treatment means:				3.8048	1	3.8048

Null hypothesis. No difference among treatments after adjusting with covariates.

F (1, 74) = .225 N.S.

Table of coefficients, standard errors and computed t-values:

Treatment + error (total)

	coefficient	SE	t-value	p
Factor I	-.7905	.8116	-.9740	N.S.
Factor II	.0164	.8341	.0196	N.S.
Factor III	.8749	.7264	1.2044	N.S.
Factor IV	.9848	.7429	1.3256	N.S.

Table of adjusted means and standard errors and t-values for differences between means:

	Treatment mean	Adjusted mean	SE of Ad. mean	t-value
Mongoloid	16.6983	17.4199	.9135	0.4963
Nonmongoloid	17.1945	16.8852	.5709	N.S.

Table 6 Discriminant analysis: Generalized Mahalanobis D-square, classification according to largest function, coefficients of Fishers discriminant function, the scaled coefficients of Fishers discriminant function and the correlations between Fishers discriminant function and variables. MFISK.

Generalized Mahalanobis D-square: 20.7535 df=5 $p < .001$

Classification according to largest function:

		Group entered:		
	Group	1	2	total
Group predicted:	1	19	19	38
	2	5	37	42
total		24	56	80

Chi-square: 13.7868 df=1 $p < .001$

Coefficients of Fishers discriminant function:

F I	F II	F III	F IV	Age
-0.4358	0.5593	0.7047	0.0173	-0.0206

Scaled coefficients of Fishers discriminant function

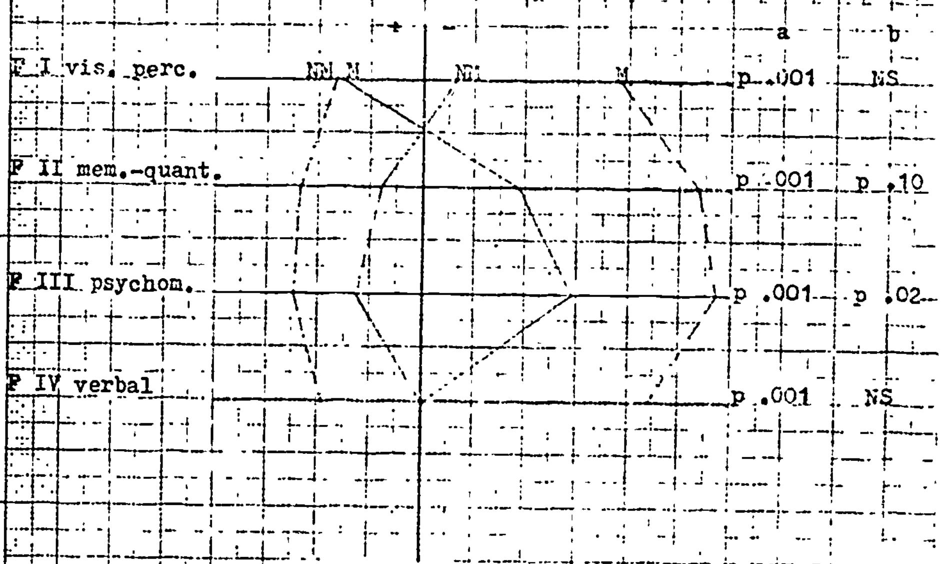
F I	F II	F III	F IV	Age
-0.4564	0.5603	0.6842	0.0175	-0.0964

Correlations between Fishers discriminant function and variables:

F I	F II	F III	F IV	Age
0.5742	0.5333	0.6610	0.0163	-0.0854

Figure 1

The ability mean profiles before and after adjustments with covariate



- - - - = without covariance adjustment
——— = with covariance adjustment
NM = nonmongoloid
M = mongoloid
NS = not significant
a = the level of significance without cov.ad.
b = " " " " with " "

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